Herbivory in Rewilding

Subjects: Agriculture, Dairy & Animal Science

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The vision of rewilding is to return ecosystems to a "natural" or "self-willed" state with trophic complexity, dispersal (and connectivity) and stochastic disturbance in place. The concept is gaining traction, particularly in Europe where significant land abandonment has taken place in recent years. However, in reality, the purest form of rewilding (Rewilding Max) is constrained by a number of context-specific factors whereby it may not be possible to restore the native species that form part of the trophic structure of the ecosystem if they are extinct (for example, mammoths, *Mammuthus* spp., aurochs, *Bos taurus primigenius*). In addition, populations/communities of native herbivores/predators may not be able to survive or be acceptable to the public in small scale rewilding projects close to areas of high human density or agricultural land. Therefore, the restoration of natural trophic complexity and disturbance regimes within rewilding projects requires careful consideration if the broader conservation needs of society are to be met. Here we highlight the importance of herbivory as a key factor in rewilding.

rewilding | livestock | traditional breeds | ecosystem services | conservation | eco-shepherding

1. Introduction

The idea of wilderness has either drawn or repelled humans for millennia. Recall Jesus's journey into the wilderness, a place of angels and devils "At once the Spirit brought him into the desert, where he was tempted by Satan for 40 days. He was there with the wild animals, and the angels took care of him" (Mark 1: 12–13). Whilst human development has spurned the wilderness, seeing it as a place of fear and loathing, Muir and Leopold brought back the idea of wilderness as untrammeled by humans, places of solitude and reflection [1][2]. More recently, there has been a movement, often associated with conservation and ecology, rooted on Soulé and Noss's ideas of rewilding [3], to bring back the wilderness or wild places [4][5]. These parts of the landscape are seen as places where nature takes its course, on which humans tread lightly and rest a while but do not stay. Rewilding ("large-scale biological and ecological restoration, emphasising recovery of native species … in natural patterns of abundance, to regain functional and resilient ecosystems" [6][7]) is becoming an umbrella term for a range of human actions to bring back the wild, a religion almost. However, there are differences of opinion about what "proper" rewilding is. As a generalization, the North American approach is more purist than is found in Europe; the latter includes human activity, particularly traditional land uses associated with agriculture (although note that Leopold was not averse to humans' "wise use" of natural resources [2]) [8]. Ultimately though, "A wilderness is an area governed by natural processes. … without intrusive or extractive human activity" [9]. Here, we consider two broad types of rewilding: (1) "Rewilding Max"—the rewilding with minimal intervention, covering large areas, with largely intact assemblages of species (i.e., biodiversity) (where intactness is rarely related to a specific historic baseline), and (2) ”Rewilding Lite” [10])—in which carefully chosen interventions are employed to achieve as many of the ecological benefits of rewilding, and with some human economic benefits (for example, sale of animal products, employment) to maximise the area over which ecological benefits (conservation of biodiversity) are achieved (Figure 1).

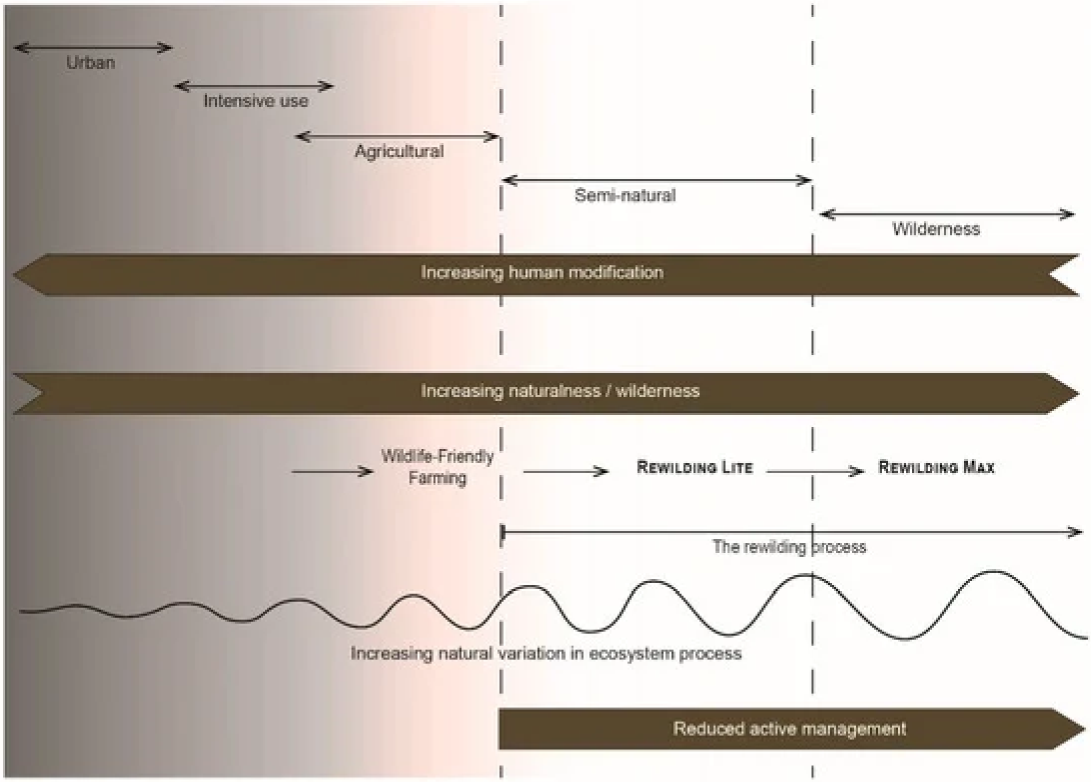

Figure 1. The Wilderness Continuum (sensu [11]) including rewilding. Rewilding is the transitional process from active management to minimal intervention (adapted from [10][11]). On this continuum, Rewilding Lite precedes Rewilding Max, and “wildlife-friendly farming” (sensu [12]) with domestic grazers that are subject to higher levels of husbandry, precede Rewilding Lite. As the conditions become wilder, ecosystems are allowed to operate within a broader range of natural variation (sensu [13]).

Advocates of each type of rewilding are often critical of the other. To characterise, the Rewilding Maxers sometimes consider Rewilding Lite as not legitimate rewilding with too much human influence, and too much compromise to human interests. Meanwhile, Rewilding Liters sometimes consider Rewilding Max as unrealistic, advocating approaches that are unlikely to be achievable without some human intervention, and exclusive of human interests and, therefore, unlikely to achieve public acceptance. Both though are interested in restoring biodiversity—variety of life and its processes at the levels of genetic, population/species, community/ecosystem, and landscape [14], and “self-willed” ecological function. Our view is that the two do not need to be mutually exclusive but sit on a continuum (sensu [10]; Figure 1), and in fact can be mutually reinforcing. This is because they are potentially applicable to different parts of the landscape—that is, one is not at the expense of the other. Rewilding Max does not allow for production offtake (but does support ventures such as ecotourism)—which means that many, currently productive pastoral landscapes would be out of scope for rewilding. Rewilding Lite does allow for some productive offtake, and, therefore, could be an alternative form of land management for agricultural land—a much larger area of the earth's surface.

This is where the landscape ecology of rewilding needs to be considered. Wild ecosystems are best embedded in a surrounding matrix that is as similar as possible. Recognizing this, Noss and Harris [13] proposed the creation of a network, of "multiple-use modules" (MUMs), in which protected areas are surrounded by integrated land uses that are complementary to the former. A similar approach was proposed by Harris [15] for forest management. If we adapt these concepts to rewilding, we imagine that Rewilding Max "cores" could be embedded within landscapes of Rewilding Lite (sensu [10]; Figure 2). It is likely that there will always be proportionally less area of Rewilding Max than Rewilding Lite, but together the total area managed to rewilding principles would be far larger than if only one approach were pursued. Critical are the spatial and temporal interactions between the two—Rewilding Max "cores" would build up "ecological memory" (sensu [16] that is, provide founder propagules that "seed" the surrounding Rewilding Lite landscapes through time as embodied in the concept of "Landscape Fluidity" [17]). In this paper, we argue that Rewilding Max and Rewilding Lite are complementary (Figure 2). We focus on how the use of traditional breeds of domestic animals could play an integral part in the adoption of Rewilding Lite, and is a more effective means of delivering desired rewilding outcomes that can also support areas of Rewilding Max.

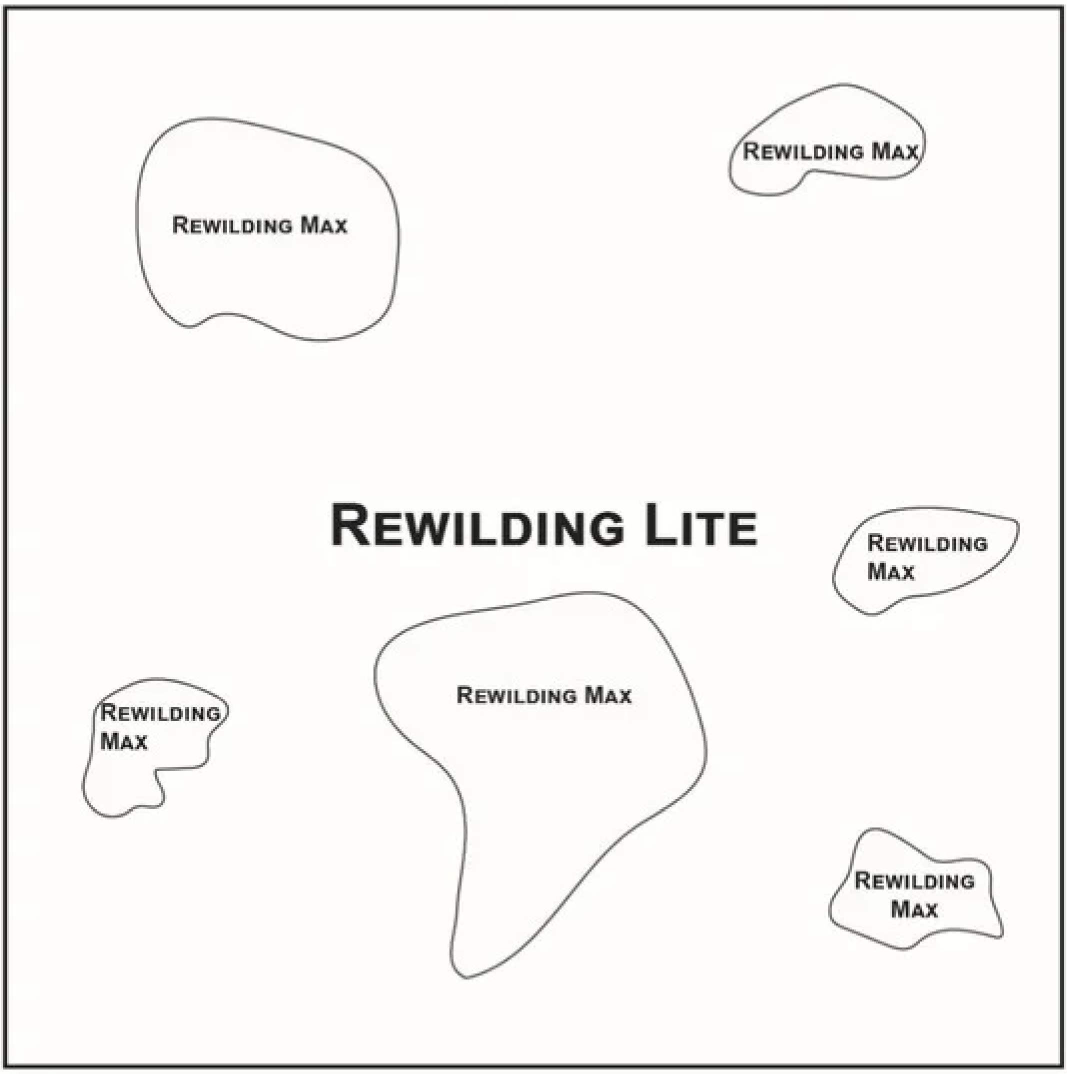

Figure 2. The potential landscape-scale complementarity of Rewilding Max and Rewilding Lite. Rewilding Max "cores" could be embedded in a Rewilding Lite matrix. Hypothetically, the juxtaposition of both "similar" land use types could increase the amount of "effective" habitat for many species that might not otherwise be viable in the landscape, for example, those with larger home ranges than Rewilding Max areas, or requiring specific old-growth features. Rewilding Max cores also provides "ecological memory" in the landscape sensu [16], that is, provide founders propagules that "seed" the surrounding Rewilding Lite landscapes through time as embodied in the concept of "Landscape Fluidity" ([17]). At the same time, Rewilding Lite areas provide a larger area for species that might otherwise be confined (and not viable) in Rewilding Max cores.

2. Key Characteristics of Rewilded Ecosystems

Landscapes managed under rewilding principles would operate within a broader range of natural variation than traditional natural resource management (sensu [13], Figure 1). There are three key ecological components of rewilded ecosystems, that is, (i) stochastic disturbance (the natural frequency and size of events such as herbivory, fire, predation); (ii) dispersal (an organism's ability to move across a landscape); and (iii) trophic complexity (a natural food web allowing, for example, detritivory, herbivory and predation) [18]. Restoration of these natural features of ecosystems requires re-instigation of the drivers of these ecological processes, through healthy soils, and native plant and animal communities, including herbivores and predators (so called “trophic rewilding”) [19]. Soulé and Noss’s [3] original work envisaged predators playing roles in systems that were essentially driven from the top down; however, herbivory is also a key process that shapes, and has shaped, a range of ecosystem attributes from nutrient cycling through to competitive interactions between plants [20]. Rewilding in this sense is, therefore, a reengagement of ecological processes throughout the ecosystem; it is very much an ecosystem- and ecology-centric view of rewilding. The tussle between “top-down” (i.e., predation) and “bottom-up” (that is, growth of vegetation and consumption by herbivores) processes is central to the future feasibility of all types of rewilding. Too much of either, for too long, is likely to drive ecosystem state changes that may be undesirable. The case of population overshoot of “rewilded” herbivores at Oostvaardersplassen (OVP) in the Netherlands is a prime example of an ecosystem where herbivores, without top-down pressure overgrazed and then starved [21][22]. The main challenge for an appropriate re-instigation of the drivers of stochastic disturbance, dispersal, and trophic complexity in rewilded ecosystems is finding out which of these specific drivers, and their intensity, are needed for a particular ecosystem to be effectively rewilded. Without a proper knowledge of these drivers, it will be impossible to make a transition from conceptual to applied effective rewilding initiatives.

How then do we achieve the best for rewilding, unguided, self-organising ecosystems, but avoid undesirable state changes? Where predation by natural predators is absent, OVP demonstrates that it is likely that we will have no choice but to intervene, and to mimic such predation through off-take of herbivores, in all but the largest and most remote settings [22]. This is fundamental to Rewilding Lite—because this means it should be possible to harvest (including through culling or management hunting of “game” animals) and sell meat derived from such management, which provides an economic basis for landowners to convert to rewilding [22]. Central to such an approach would be domestic herbivores that can handle lower levels of husbandry and have meat that has economic value. We contend that locally adapted traditional breeds of livestock are, by definition, ideal for this role, and may be better adapted and provide more valuable products than “de-domesticated” breeds (see below).

3. Herbivory Is a Key Part of Rewilded Systems

Herbivory, a key driver of bottom-up processes, is complex with diverse impacts upon the ecosystem in which the community of herbivores exists (Figure 3) [20]. The individual decisions by animal foragers, at small scales, determine the individual plants and the parts of plants that are selected [23]. These decisions are scaled up through the amount of vegetation an individual consumes, how the individual relates to the landscape, and its social context across the day, the week, month, and year [24][25]. The density of herbivores of a species, and the assemblage of herbivores in an ecosystem all determine the distribution and extent of herbivory, and have indirect effects on ecosystems through trampling, rolling, digging, defecation and urination (Figure 3). Large mammalian herbivores are, therefore, essential in any rewilding project or system, and there are good reasons to use our knowledge of herbivore/ecosystem interactions to support the outcomes envisaged in rewilding.

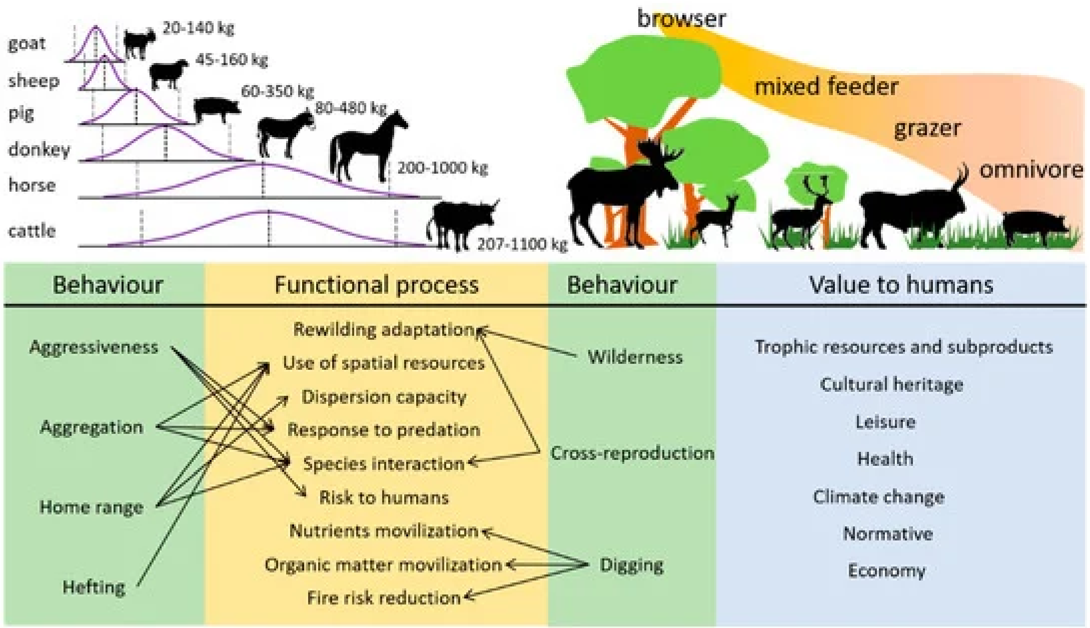

Figure 3. What species/breeds of landraces can be incorporated into Rewilding Lite? We propose classifying species and breeds of domestic livestock within a multidimensional space attending to (i) their potential functional role (as a function of their body size, feeding style and behaviour) and (ii) the benefits for humans. Their position in the multidimensional space will suggest what landraces are appropriate for a specific functional role in a particular environment.

Firstly though, a key consideration in the case for Rewilding Lite, and the use of domestic breeds, is that the growth in the concept and application of rewilding is occurring in a context of increasing stress on ecosystems, with the human population of the globe currently at around 7.5 billion, and likely to reach 9 to 11 billion in the next 30 years [26]. Most of this growth in human population will happen in the developing world. This population is also getting richer [27], leading to changing dietary habits, as people shift from a predominately grain-based diet to one that includes more meat, initially poultry but then pigs, and red meat from goats, sheep and cattle [28][29]. To meet this demand, the projection of land area under permanent pasture in lower- and middle-income countries (particularly in South America and sub-Saharan Africa) for the period 2010–2030 is that it will expand by ~320 Mha [30]. This will involve an increase in livestock numbers of between 40% and 50% for water buffalo, *Bubalus bubalis*, and cattle, *Bos taurus*, and 30% to 45% for sheep, *Ovis aries*, and goats, *Capra hircus* [31]. This additional grazing pressure is likely to increase the stress on rangeland ecosystems used for extensive livestock grazing. This means that putative Rewilding Max core areas of the future will rarely be able to effectively operate within the context of what is happening in the surrounding matrix within which they are embedded. It is worth noting that, as compared to livestock (including pets) that make up 66% of the total biomass of land mammals today, wildlife including large herbivores make up less than 3% (and humans the remaining 31%) [32]. This means that large areas (over 25% of the Earth's dry surface) has been under agricultural production; much of this is extensive livestock grazing. This has profound effects on the way in which vegetation communities are being, and have been shaped, by large mammalian herbivores, primarily livestock. In many cases rewilding, as often conceptualized, will constitute the abandonment of this agricultural land [33]. Theoretically this could form part of the "land sparing" component of biodiversity conservation [34], where agricultural land is managed intensively to achieve a high yield from relatively small area of the landscape, allowing conversion of remaining areas for conservation [12][34]. Is such managed abandonment, perhaps using Rewilding Max, feasible? Can such a binary approach to whole landscapes achieve biodiversity goals? Will such approaches have the requisite social license?

The proposed alternative to land sparing is “wildlife friendly farming”, which is where agriculture and biodiversity are integrated across the whole landscape, but agricultural yields are lower per unit area than under land sparing [12]. Rewilding Lite is a step further on the wildness continuum and sits between wildlife-friendly farming and Rewilding Max (Figure 1). The key distinguishing feature is that wildlife-friendly farming (and similar concepts such as High Nature Value farming and conservation grazing) is still focused on production (albeit with biodiversity benefits), whereas Rewilding Lite focusses on delivering wildness, with a co-benefit of meat products (from domestic livestock and game) that can be sold to support the management approach, and mimic top-down (that is, predation) processes [35]. Further, in the former, domestic livestock are still husbanded whereas with Rewilding Lite, husbandry is minimal, and animals are “self-willed”, that is, free mate choice, able to form “natural” social structures, and determine their own spatial movements [22]. We contend that Rewilding Lite could be an alternative to more interventionist wildlife-friendly farming (Figure 1).

This concept is highly contentious because domestic livestock have an ambiguous position in conservation and rewilding. Some question their use as a legitimate component of rewilding because livestock are considered as historically part of the “taming” of the wild, that is, that they detract from “wildness”. This is particularly the case in Rewilding Max where human activities are separated from natural processes [36]. Others see them as important “tools” to deliver conservation outcomes (for example, [37]). As we outlined above, it is impossible to rewild without restoring herbivory at scale, and domestic livestock are very well adapted to do this. The key question should not be about whether the animal species is wild or domestic, but rather which is most effective to restore the functional ecological processes that we want.

In many areas the wild species that used to graze and browse the landscape are long extinct [38][39][40]; even when places have been put aside for wildlife, populations of wild native species take a long time to respond, by which time ecosystems may have been tipped into a new, degraded stable state, for example, dominated by fire, shrubs, or weeds [41]. “Herbivory” can be achieved through other means, most of which, for example, controlled burning or slashing, are labour intensive, have limited selectivity at the scale effected by herbivory, and are impractical to apply over large areas. An alternative is for land managers to take a more flexible, deliberative approach to intervening in rewilding projects, and take a second look at traditional domestic breeds to provide the herbivory service in rewilding landscapes (Figure 3). This may only be in the early phase of the project, but it could also need to be continued for many years if wild species are no longer extant or the existing ones are on low numbers.

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